DIMENSIONS NBS

The magazine of the National Bureau of Standards U.S. Department of Commerce

October 1978

DATA IN FOCUS. See page 14.

COMMENT

THE ROLE OF ANALYTICAL CHEMISTRY

Analytical chemistry is the science of identifying and quantifying the composition of materials. The influence of analytical chemistry in modern technology and on the quality of our lives is pervasive—perhaps more so than most people realize. For example, small amounts of impurities in materials may have a dramatic effect upon performance: the efficiency of solar conversion devices, the light transmission of optical fibers, the potential failure of superalloy components in jet engines, or the conductivity of copper. Clinical chemistry, employed in thousands of hospitals and medical laboratories, has been undergoing an enormous growth over the last decade; increasingly sophisticated analytical chemical tests are being used to reveal signs of medical disorders or to monitor levels of therapeutic drugs. The detective searching for clues, the museum curator seeking to verify the authenticity of an art object, the geologist tracing mineral deposits, the materials scientist conducting a failure analysis, the local government official reporting the air quality index, and the occupational health specialist sampling a workplace environment—all rely upon the results of chemical analytical measurements.

Although analytical chemistry has been around for a long time, accurate analytical measurements are often very difficult to make. Intercomparisons of measurement results among laboratories—even "good" laboratories—often reveal significant variations. Because analytical test results are used in "decision processes," significant variations can lead to wrong decisions. Even if results are questioned, the simple, but often expensive, expedient of re-analysis may be impossible because many samples are one-of-a-kind. For these reasons, measurement quality assurance in the form of methods of known reliability or measurement standards needs to be included as a key element if measurement systems are to be reliable.

Providing measurement quality assurance and producing new methods for measuring composition are primary functions of the Center for Analytical Chemistry—one of five centers within the National Measurement Laboratory. Over the years, the Center for Analytical Chemistry (formerly the Analytical Chemistry Division) has developed or improved a number of analytical methods and has significantly extended the state-of-the-art in chemical analysis. Many of the groups in the Center, for example those working in micro-analysis, mass spectrometry, atomic absorption, gas analysis, and activation analysis, have been recognized for years as among the best in the world. NBS scientists working in new areas, including organic analysis, the application of lasers to analysis, and resurgent activities in electrochemistry and emission spectroscopy, are rapidly achieving a similar status. The variety of competences, the level of expertise, and the diversity of problems investigated at NBS are not found in any other single analytical laboratory in the world. These competences are heavily utilized in the development and certification of Standard Reference Materials used in the making of steel and other metals, in the safeguarding of nuclear materials, in measuring the performance of internal combustion engines, in performing analyses in clinical laboratories, and in making environmental measurements.

The field of analytical chemistry is undergoing a rapid growth and an increase in scientific complexity. This "rebirth" is stimulated by the many applications of analytical chemistry to the areas of public importance already cited. In a technological society there are, in addition, numerous tradeoffs that must be made—between energy production and environmental quality, for example. These need to be based on reliable data. Analytical chemistry is critical in all aspects of such tradeoffs, from the development of energy technology and the regulations involving its use to the mining and smelting of metals, the development and use of agricultural chemicals, the use of food additives and preservatives, the utilization of minerals such as asbestos, and so on.

The increasing scientific complexity and the diversity of analytical chemistry point to numerous measurement and standards challenges ahead, such as making measurements at the parts-per-trillion concentration level and lower; characterizing small particles; developing methods for detecting minute constituents in blood; separating, detecting, and monitoring the tens of thousands of organic and organo-metallic compounds; making measurements of metals and organic species in tissue and food matrices—to list just a few. For many of these applications, measurement methods are not now available; for others, the basis for standardization is entirely undeveloped.

The challenges are there. The staff of the Center for Analytical Chemistry has the desire to meet them and the foundation of technical expertise to build on.

Philip D LaFleur

Philip LaFleur
Director, Center for Analytical Chemistry
A309 Chemistry Building
National Bureau of Standards
Washington, D.C. 20234
301/921-2851

DIMENSIONS NBS

The magazine of the
National Bureau of Standards
U.S. Department of Commerce
Volume 62/Number 10

October 1978

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UPDATE

The Benefits of Going Metric

Or, What's in It for Me?

by Jeffrey V. Odom

FEELINGS run strong and deep on both sides of the metric fence these days. People in the antimetric camp do a slow burn to think that they might swelter in the heat of a 35-degree day. And why shouldn't they burn over the nuisance of dealing with a new system of units? Who needs the annoyance of adjusting to 50 as a speed for residential areas instead of expressways—without getting a ticket? Furthermore, parents may object to confronting the metric system in the sanctity of their own homes; homework was difficult enough in the first place.

Quite seriously, metric conversion does impose to an extent on the way people live. Naturally, people question such an imposition: "Why is it necessary? What's in it for me?"

In the daily round of living, the disadvantages of metric conversion will be small annoyances, such as those already mentioned. Also, on this level the advantages may seem small. But there is something for almost everybody in going metric. And if we look at the major segments of our society as well as the individual, there are considerable collective benefits.

In Industry

One area which will enjoy substantial advantages through metrication is the industrial sector. In fact, U.S. industry has been one of the leaders in our move to metric. The benefits for industry include:

• Foreign trade: This will be easier when we use the same measurement language, engineering standards, and standard practices as the rest of the world. In some nations, nonmetric measuring equipment and tools are not allowed to be imported. For example, in a growing number of countries, weighing and measuring instruments of all types require import permits; approval is given only if metric units alone are used. In the Common Market countries, metric units must be used on all labels, in service manuals, and even on shipping invoices.

Using metric will eliminate an obstacle to international trade . . .

Even when there are no legal requirements for metric, nonmetric usage itself is sometimes a trade barrier. For example, an equipment purchaser, who might want to perform simple repairs on that equipment, would like to be able to purchase replacement nuts and bolts and other simple components locally. In many cases with U.S.-made equipment, such items must be specially ordered—with corresponding delays in repair time.

• Standardization: This can be achieved on a worldwide basis for those companies with operations both in and outside the United States. Many large companies expect sizable savings when their entire international operations can operate with the same set of engineering standards.

• Rationalization: The change to metric will present a once-in-a-lifetime opportunity to reduce the number of available sizes or types of a wide variety of components. In many cases, these sizes or types

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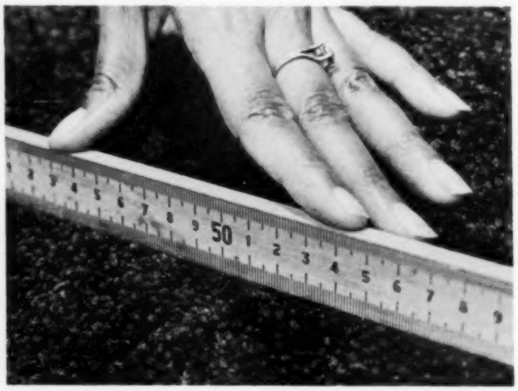
Odom is metric coordinator for the National Bureau of Standards.

have evolved over the years without following any uniform practice. Often there are several slightly different sizes or types when one size or type would normally be adequate. For example, there are currently 59 different standard sizes of screw threads in use in the United States. The proposed metric replacements will use only 26 such sizes, presenting obvious advantages in inventory control.

• Modularization: This concept, not unrelated to rationalization, involves taking advantage of the changeover to better plan the sizes of things that fit together so that they can do so with little or no "cutting and fitting" at the time of assembly or construction. For instance, undercounter kitchen drawers currently come in standard 24" widths and can easily be removed to accommodate standard-sized dishwashers. Metric conversion will provide an excellent opportunity for the construction industry to adopt this practice on a wide scale and drastically reduce the amount of cutting and fitting now necessary on the job. For example, a 10-centimeter "module" can be adopted and all doors, windows, sheets of plywood, etc. would be made to multiples of this size and would thus fit together with little or no waste.



. . . make routine computations easier . . .

In Education

Industry has not been alone in leading the push to metric; education has also been in the forefront of the change. There are substantial advantages here as well.

Educational advantages occur primarily because metric is a decimal system, as is our currency sys-

. . . simplify teaching and learning.

tem, and as such is easier for teachers to teach and student to learn. For example, consider the following:

• There are no awkward conversion factors to memorize in metric. There are 100 centimeters in a meter, 1000 meters in a kilometer. Do you remember how many yards there are in a mile (1760) or how many acres in a square mile (640)—not to mention the number of square feet in an acre (43 560)?

• Moving between units is much easier in metric. For example, to calculate the number of inches in 47 miles (after you remember the proper factors), you write:

$$\textbf{47 miles} \times \frac{\textbf{1760 yards}}{\textbf{mile}} \times \frac{\textbf{36 inches}}{\textbf{yard}} =$$

$$\textbf{2 977 920 inches.}$$

In metric, to find the number of centimeters in 47 kilometers:

$$\textbf{47 km} \times \textbf{1000}\frac{\textbf{m}}{\textbf{km}} \times \textbf{100}\frac{\textbf{cm}}{\textbf{m}} =$$

$$\textbf{4 700 000 centimeters.}$$

When decimal arithmetic is learned, the calculation can easily be done, practically as quickly as you can write out the problem.

• Similarity with our currency can provide helpful keys in learning the new metric terms. For example, just as there are 100 cents in a dollar, there are 100 centimeters in a meter.

• Since decimal notation is normally used with metric, complex fractions can be de-emphasized in our schools with a considerable saving of time in elementary mathematics. Common fractions, such as ¼, ½, or ⅔, will be used, but values such as 3 13/32" or 5 29/64" will be replaced by 8.65 cm or 13.85 cm, figures which can much more readily be added if you need to. (Do you remember how to add 3 13/32 + 5 29/64?)

For Consumers

The benefits of going metric are much less obvious for the general public, and this is perhaps one reason why many people are still a little uneasy about the changeover. For example, as our industry improves its foreign trade, the economy will benefit, which is good for all Americans. This is quite logical, but it is also indirect and hard to measure for any one individual. There are, however, some direct advantages for the general public:

• Calculations at home will be easier. For example, if you are planning to purchase wall-to-wall carpeting, now sold by the square yard, you will likely measure the room in feet and inches and need to convert that to yards before determining the necessary area in square yards. After we go metric, the room will be measured in meters and the carpeting sold in square meters, a much easier calculation.

• Also, in adjusting food recipes for more or less-than the designed number of servings, we frequently are faced with awkward calculations. For example, if you have a recipe for six and you only want to serve two (one-third of the recipe), how much of an ingredient originally given as 1¾ cups would you use? In metric, the equivalent would likely be given as 450 milliliters (mL), which is easily reduced to 150 mL. (Incidentally, ⅓ of 1¾ cups is ⅓ cup + ¼ cup, if you have a ⅓ cup measure, or ½ cup plus 1 tablespoon and one teaspoon.)

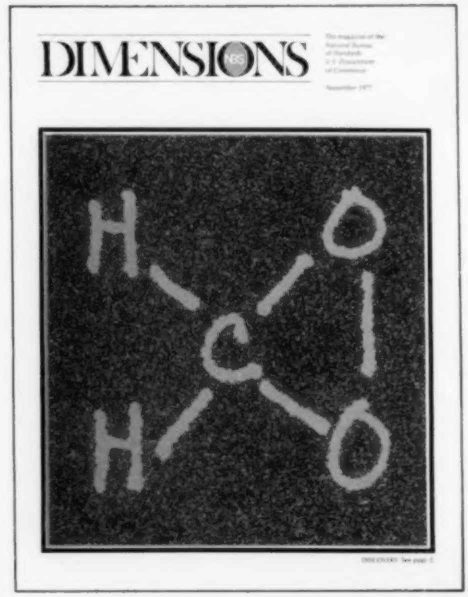
• People who like to work around their homes will find such work easier when the number of different screw sizes are reduced and when things fit together easier, with less cutting and fitting. Care must be taken, however, to insure that parts built to old standard sizes continue to be available for repair or remodeling projects for a long time to come.

• Confusion will end between ounces of liquid measures (32 in a quart) and ounces of weight (16 in a pound) and between liquid and dry pints and quarts. (Did you know that 1 liquid quart equals 0.86 dry quart?)

• Comparison shopping will become easier if standard sizes are adopted as we go metric. For example, which is the better buy: 17 ounces (of weight) for 79¢, or 33 ounces for $1.50? In metric, 500 grams for 82¢ is obviously a better buy than 1000 grams (or 1 kilogram) for $1.67. Incidentally, in the first case, the larger 33-ounce size is more economical.

Probably the most positive aspect of the metric changeover can be seen only from the perspective of the future. If as seems likely we continue to go metric, we will one day, perhaps in ten years, get there. Once we are there, all the advantages that accrue along the way will remain. The disadvantages —costs and annoyances—will be over. The rest will be metric gravy. □

Special for educators



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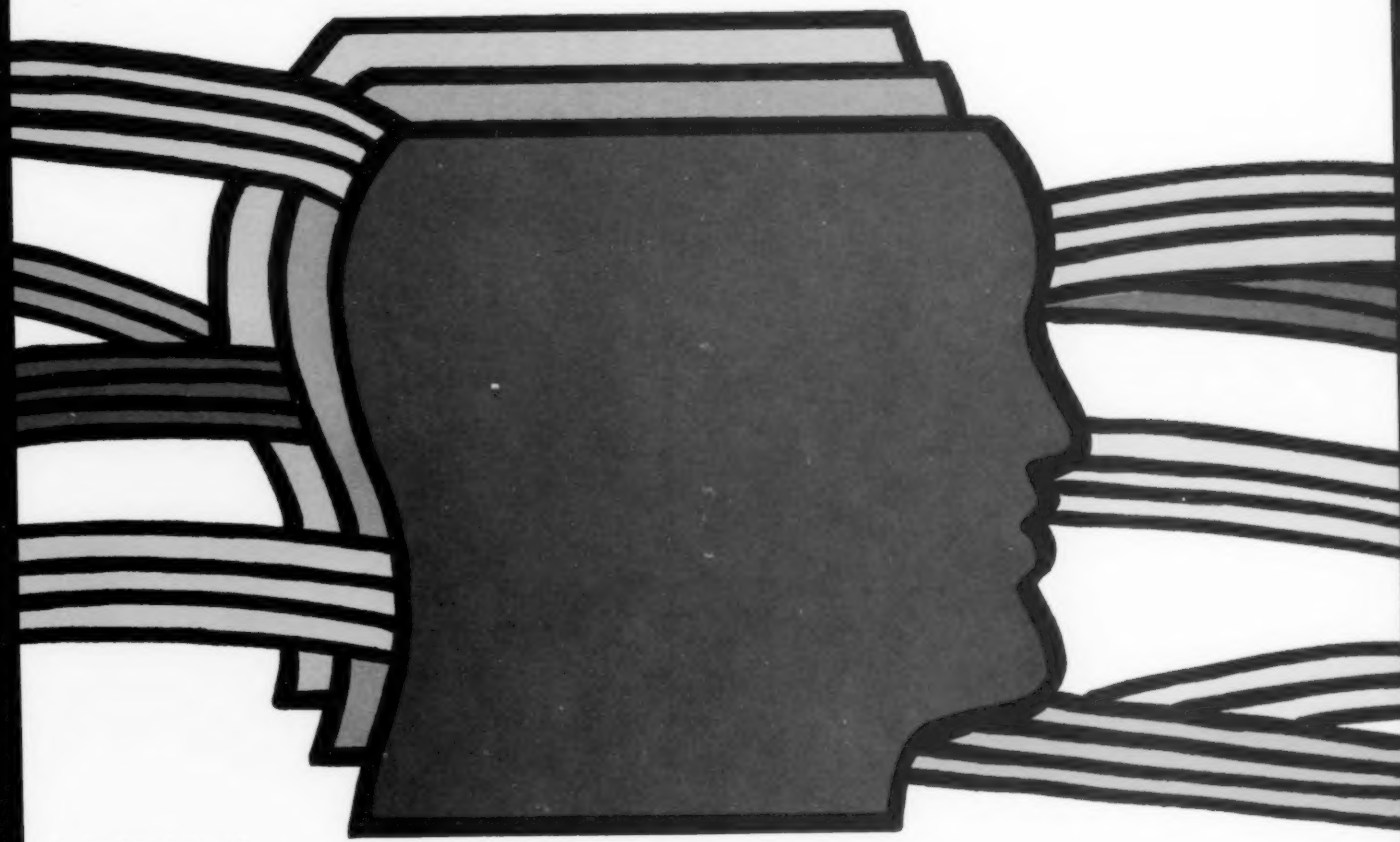
In Reply to "Dynamics of Information Systems and Users"



by Franklin P. Huddle

In the February 1978 issue of DIMENSIONS/NBS, Dr. Stephen Rossmassler of the NBS Office of Standard Reference Data invited comment on the subject of information systems and users. This article is one response to Steve's invitation, an invitation that remains open to others who would like to continue this dialogue in DIMENSIONS.

THIS essay was prompted by an article that appeared in the February 1978 issue of DIMENSIONS/NBS by Steve Rossmassler, titled "Dynamics of Information Systems and Users." He offers eleven propositions or hypotheses, most of which I agree with, at least in part. At the risk of losing a friend and setting up a few strawmen, I'll undertake to paraphrase his eleven pillars of wisdom. They were presented as a first cut—an attempt to build a prescriptive framework of understanding about information and information systems. My interpretation of his propositions is as follows:

1. Information users must learn to ask the right questions.
2. The effort required to absorb received information is a great obstacle.
3. The delivery of information to users must be selective.
4. All information can't be packaged and delivered by a single system.
5. Evolution of an effective information system is a learning process involving manager and user of information.
6. An information system should start small and expand in response to need.
7. Information users are unable to specify new information system requirements.
8. Computers are a mixed blessing (or mixed curse?)
9. Somebody besides the user must plan the growth of an information system.
10. For information centers to cooperate in meeting the interdisciplinary needs of decision makers addressing problems of national concern requires special attention.
11. All specialized information systems should be conceptually integrated into a single system in

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Dr. Huddle is a senior specialist in science and technology with the Congressional Research Service of the Library of Congress.

"I would agree that in theory, the primary burden of effort in communication is on the receiver. It was ever thus. When I was a youthful Boy Scout, I discovered early that *sending* wigwag signals was ever so much easier than *receiving* them."

the sense of being logically coherent subsystems, interactive, and without duplication.

In comment on Steve's first point, I would agree that in theory, if not in practice, the primary burden of effort in communication is on the receiver. It was ever thus. When I was a youthful Boy Scout, I discovered early that *sending* wigwag signals was ever so much easier than *receiving* them.

Later on, I became acquainted with the "wet-spaghetti-through-the-keyhole" syndrome. It says that the transfer of technology is like passing wet spaghetti through a keyhole. It can't be pushed. It has to be pulled.

The second point relates to the first. One possible interpretation of this second point I would disagree with: the idea that the greatest cost to the information user results from the effort required to absorb the message. On the contrary, I suggest that the greatest potential cost to the user can result from such mishaps as:

—the receipt and engineering application of incorrect information;

—the misuse of information owing to failure to learn its special constraints;

—belated recognition of uncertainties resulting in delay and inaction;

—insistence on great redundancy to overcome insecurity caused by previous mistakes; and

—difficulties in sorting out or evaluating conflicting data from competing information systems of differing quality.

There are a number of other sources of costs but these will serve to illustrate the point.

Surely information systems must be selective in the product they deliver. There must somehow be a one-to-one relationship between the needs of the requester and the product delivered. But what does this mean? In the Congressional Research Service, where the author is gainfully employed, the function is that of responding to requests for information and analysis from the Legislative Branch. It is generally recognized that if this function is to be properly performed, it is necessary for CRS staff members to provide the user with three products:

(1) The information requested;

(2) The information the requester thought he was requesting; and

(3) The information he should have requested.

In difficult subjects, of course, there are almost infinite permutations of this formula. And clearly, the problem takes us back to proposition Number One—except that to ask the right question, the questioner sometimes needs a lot of coaching. As

they say, "a fool can ask questions a wise man can't answer." Questions need to be tailored to be answered. What does the questioner really want to know?

When Samuel Morse went to Joseph Henry for advice on how to send an electrical impulse along a conductor, how did he ask? I'm sure he didn't ask, "How does one collapse a coil to induce a voltage surge?" There had to be a considerable dialogue between the two men before Henry could understand what was wanted, solve the technical problem, and then convert his answer into understandable terms to help the entrepreneur.

Several years ago I proposed a scheme to set up, on an experimental basis, a few offices in field laboratories or installations of the Federal Government close to major industrial centers manned by retired professional engineers (metallurgical, mechanical, etc.) to assist small industrial companies to prepare to ask questions in the development of new technologies or innovations. The idea was that such people needed help, first, to identify precisely what it was they wanted to know; second, how to ask for it; and third, where to go to get the best answer for the intended purpose. I was unable to persuade anyone that the idea merited further effort, but I still believe in it.

Steve's points 4 and 11 seem to be contradictory, but I think I know what he means. If technical information is to be properly received, massaged, selected, condensed, related, structured, evaluated, interpreted, purified, retained, called out, packaged, and delivered, somebody really knowledgeable in that technical field must do it. To expect any single information center to be able to attract and hold all the necessary experts in all fields of technical subject matter boggles the imagination.

On the other hand, it is surely necessary that the user of information should be able, once he learns the trick of extracting facts from one center, to go with equal facility to others. If a problem involves data from several centers, the units of measure, the terminology, the degree of reliability, and other technical criteria should be uniformly met.

One amusing problem was encountered by our stockpiling program. A remarkable variety of units was involved—pounds of wool, hundredweight of abaca, long tons of tin (not piculs, as in Malaya), gallons of castor oil, long dry tons of metallurgical grade manganese (dioxide), and so on. Other materials units in use at the time included "base boxes" of tinplate; bales of latex; drums (55-gallon) of oils; lifts, bundles, and the amount of crocidolite asbestos that could be carried across the Bolivian altiplano by an average-sized llama (I think it was 76 pounds and I forget the name.) Oh, yes—and flasks of mercury.

Propositions 5, 6, 7, and 9 are all variants on the same theme: how does one go about designing and starting up an information system.

I think I should start by defining what I mean by the word "system." As I understand it, a system is a technological contrivance, an articulated set of subsystems, whose several parts are designed to optimize the performance of the whole, whose performance is directed from a command center, whose relation to the external world is responsive to feedback from a set of sensors, whose internal structure is sustained by positive attention to the minimizing of entropy, and whose total performance subsumes a single, simply expressed objective. One of the problems with many government information centers is that they are not true systems; they strive for a mix of objectives that too often contravene one another.

For example, one theory of information systems is based on the expectation that the proper use of technical information justifies basic and applied research investment by converting it into a taxable technological property in the hands of the entrepreneur.

Another theory is that since the public has invested in government-supported research and development and since the results of applying the fruits of R&D are publicly beneficial, the dissemination of technical information should be treated as a free public service (like the public library).

Another theory is that because information is so unmistakably of economic value to the entrepreneur, the costs of delivering it to all users should be defrayed by the users.

Another theory is that user charges are difficult to impose because the request must precede receipt of the information, but its utility cannot be determined until after it is received so that the user is asked, in effect, to pay for a "pig in a poke." (The term "poke" in this context means a sack—so that the buyer can't see what he's paying for).

One interesting concept of a total system of systems was that offered in an early draft of the bill that eventually turned into the Science and Technology Policy Priorities and Organization Act of 1976 (P.L. 94-282).

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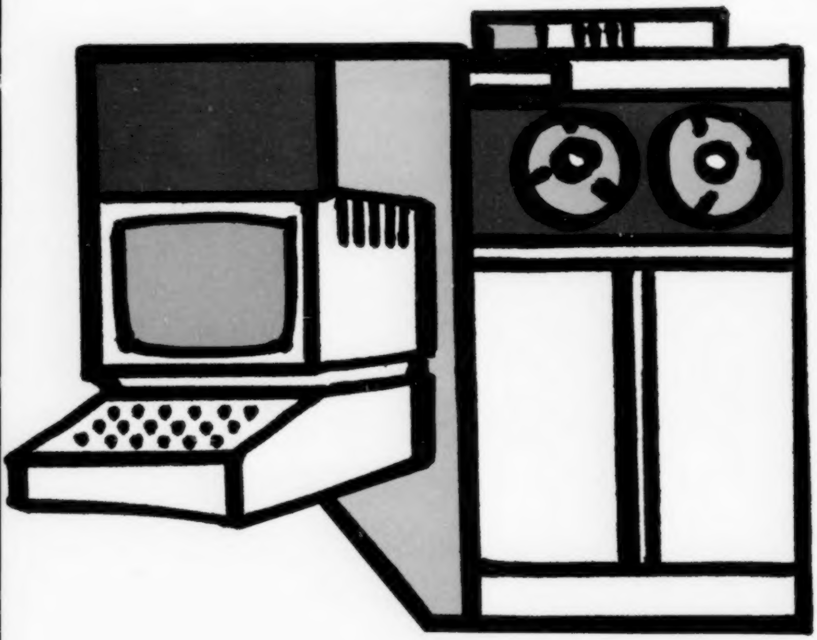

One Title of that early bill proposed to create a Department of Science and Technology Operations. It would include the National Bureau of Standards, the National Science Foundation, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration. It would also include a new corporation for technical information.

The functions of this corporation would be to distribute funds to the various public, private, and mixed public/private information activities of value to technical users. It would fund or encourage the creation of new centers found necessary and useful. It would fund arrangements for the coordination of the various centers and set standards for uniform data bases and information packages. It would ensure a proper flow of information to users. And it would fund arrangements for communicating to potential users the kinds of services available and how to obtain them.

A considerable array of kinds of technical information are still not readily available to the U.S. technical community. For instance:

—phase diagrams of metals
—translations of foreign papers
—composite materials property data
—corrosion prevention technology
—small scale foreign technology.

Another question is raised by Steve's proposition 8. What good is the computer? On the one hand, the computer can do what it's told remarkably quickly, and faster all the time. On the other hand, it is thus far limited to the simplest kinds of instructed response. It can think, but only within narrow limits. Moreover, going back to that point about the "Tyranny of Numbers," there is an hypnotic quality about the figures that creep across the illuminated screen of a cathode ray tube. We are led to accept them even when we do not know their origin, or degree, or range of probability. Garbage in, garbage out, we keep saying, but we don't always remember it. And too often garbage is what we get.

Another failing of computers in the management of technical information is the fact that the ease with which they access new information tends to invite unselectivity. Memory banks tend to accumulate much unusable or redundant information. This is awkward at best, but with technical fields in which the state of the art is changing rapidly, it becomes disastrous. Every data bank requires periodic purging of obsolete information, which is difficult under all conditions and doubly so with highly dynamic technologies.

Item 10 I have saved for last. It has to do with the use of technical information by political decision makers in addressing major public problems with a substantial technical content.

The process has a built-in degree of uncertainty because no administrator can ever have at his disposal all the information he needs to solve a prob-

lem. Some information cannot be supplied in quantitative form. Some cannot be quantified. And the decisions in many if not all public issues involve value judgments, arrived at subjectively, as well as the hard technical facts.

Worse yet—the technical facts are rarely pure. Too often the non-technical policymaker is at the mercy of the technical analyst. The other night I heard a scientist challenge an "environmentalist" on a television program to say what his "doctorate" was in. The victim confessed it was in American studies and the scientist saw himself as the victor in this contest of words. Of course the subject was geology, and the scientist's own expertise was in nuclear physics, but no matter. The primary problem, as the physicist had declared in opening his statement, was institutional rather than technical, and everyone knows that nuclear physicists have the edge over lesser disciplines like the social sciences in organizational matters.

One point that Steve made continues to nag me. It is that business about the geometric increase in the rate of information generation. Selectivity is important, of course. We all know that story about the little girl who read a book about penguins and concluded that it told her more than she wanted to know.

One solution to the problem is for the information seeker to stand face-to-face with the best information source and conduct a dialogue. According to Fred Bucy,* this is the most effective form of technology transfer and—when conducted with a potential adversary—the most dangerous.

Years ago in a whimsical moment, a colleague remarked that every corporation ought to have its own research department engaged in the acquisition of technical information. It did not, he said, have to be very large or expensive. In fact, one of the most efficient and cost/effective research departments in his experience was a single young, intelligent, and very inquisitive researcher in the employ of a principal competitor.

In the early days of the National Science Foundation, it was quite the fashion to approach the subject of information management by endless surveys of users. I recall sitting in on one NSF meeting when someone came in with a new approach to user surveys. He had invented an alarm clock (of the old Westclox design) that would go off at random intervals. The idea was that this clock, with its alarm at intervals, would be put in the offices of a few thousand scientists. Whenever it sounded off, they would immediately stop work and report on what kind of information they were receiving at that time, and from what medium.

I do not wish to seem critical; doubtless the information to be thus obtained would be of value. But for a scientist in the laboratory to be able to concentrate with that infernal machine ticking away —for him to engage in delicate, precise operations under these trying conditions—seems highly unlikely.

One is reminded of the golfing amateur who defeated the golf pro by demanding a handicap of three "gotchas" and exercising only two of them. (If you don't know the story, ask a friend).

Undoubtedly, the management of technical information will continue to grow in importance, not only in the United States but worldwide. As Steve Rossmassler pointed out, information is the primary product of a services economy, which is certainly what this country has. Increasingly, the other nations of the world are moving in this direction. Accordingly, there is growing up a whole series of knowledge bases—global, national, disciplinary, commercial, institutional, and governmental. It is not inconceivable that the international contests of the future among competing ideologies will be decided not by weapons or wealth, but by relative skill in the management and use of information. So where do we stand, relative to the rest of the world, in this very vital field? □

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* Bucy is president of Texas Instruments, Inc. and a member of the Defense Science Board.

Are You on the Wanted List?

by Madeleine Jacobs

THE National Bureau of Standards is seeking homeowners to participate in a study aimed at developing better information about the performance and use of thermal wall insulation.

The study is being carried out by architect John Weidt of Minnesota under contract to NBS. The project is sponsored by the Department of Energy Office of Weatherization Assistance. Weidt recently completed a similar study of insulation in Minnesota houses.

Homeowners who have had thermal insulation installed in the walls of their houses at least two years ago are eligible. The three types of insulation that will be studied are urea-formaldehyde foams, cellulosic loose fill, and mineral fiber loose fill.

Weidt is looking for homeowners in these different climatic regions of the country:

—Northern (Minnesota, New England)
—Middle Atlantic (Maryland, Virginia, District of Columbia)
—Southern (North and South Carolina, Georgia, Alabama, Louisiana, Florida)
—Midwest (Ohio, Kentucky).

In the study small portions of the wall will be removed either from the outside or inside of the house. The insulation will be inspected and observations noted on such factors as corrosion of metal wall objects, moisture accumulation, odor, fungus or mold growth, and workmanship during installation. Weidt will also be studying settling of loose fill insulations and shrinkage of foam insulations.

Small samples of the insulation will be removed and sent to laboratories for testing their thermal conductivity, density, and moisture content.

Homeowners will also be interviewed by Weidt to determine their satisfaction with the results obtained from insulating the walls of their houses and to determine the effects on their fuel consumption.

Weidt has indicated that the walls of the homes will be repaired and restored to the homeowner's satisfaction. For participating in the study, homeowners will receive a clock thermostat, an energy saving device that automatically controls the temperature of the house according to an adjustable time schedule.

Wall insulations are of particular concern to the Federal Government since there is insufficient information about the performance of these materials once they are installed. Although unseen, wall insulation must continue to retain its insulating properties and remain compatible with the structural and other materials with which it is in contact.

"The government is sponsoring the study because substantial energy savings as well as the health and safety of the occupants depend on the quality and performance of these largely unseen insulations," says NBS Project Leader Dr. Walter J. Rossiter, Jr. "In addition, millions of dollars will be spent by homeowners installing insulation in their houses."

The results of the study, he notes, will be used to develop needed information on the performance of insulations in order to update guidelines and standards for their application and use.

To participate, homeowners should know the type of insulation in their homes and approximately when it was installed. Only retrofitted houses, i.e., houses with insulation installed after the completion of construction and being occupied, will be considered for the study; houses originally built with wall insulation are not included. Interested persons should contact:

John Weidt Associates Inc.
Jonathan Lake Village Center
Post Office Box 401
Chaska, Minnesota 55318, or call Weidt collect at 612/448-6920.

Deadline for participation in the study is December 1, 1978. □

Jacobs heads the NBS Media Liaison and General Publications Groups in the Public Information Division.

The State of
National Standard Reference Data

Last spring, the Subcommittee on Science, Technology, and Space of the Senate Committee on Commerce, Science, and Transportation heard testimony on the Standard Reference Data Program of the National Bureau of Standards. Among those testifying was Dr. Donald Johnson, deputy director for programs for the NBS National Measurement Laboratory. The following is taken from his testimony and from the subsequent question-answer session conducted by Senator Adlai Stevenson, III, chairman of the Subcommittee.

LET me begin by clarifying the term "data" for you. Data in the context of the Standard Reference Data Act of 1968 refer to numerical values for physical or chemical properties of well characterized materials. The measurements which generate this kind of information are made as part of the normal scientific research and development work performed daily by scientists and engineers around the world. The data are reported along with other research results in thousands of journals and technical papers each year.

Unfortunately, data in the form available in the primary scientific literature vary widely in quality and often do not cover the range needed for a given application. Potential users of data are hard pressed to find the specific numbers they seek, or having found them, to assess their applicability.

Our job starts with the retrieval of data in a specified subject area from the primary scientific literature. We evaluate these data for accuracy and consistency, supplement the data to cover the full range which users require, and finally prepare and distribute tabulations for general use.

This kind of analysis requires considerable experience and is an expensive, time-consuming process. It goes far beyond the mechanical operation of collecting the data. It involves detailed comparison of experimental values with theory in order to develop techniques for prediction or extrapolation into new regions. Occasionally, a limited number of measurements must be made to test the theory or the quality of the predictions.

The final product of such an effort is a complete set of data, well documented, and of known accuracy, which can be used for a wide variety of applications in research, engineering, and industry. Typical users will include industrial engineers, quality control engineers, and researchers in chemistry, physics, engineering, and biology. Applications are as esoteric as plasma diagnostics in energy production, and as commonplace as the design of street lights.

In passing the Standard Reference Data Act, Congress recognized the traditional role of NBS as the Nation's foremost measurement laboratory, where responsibility for the quality and reliability of technical data could best be placed. It was also recognized that NBS could help consolidate the results of the Federal government investment in research and make those results more useful to science and technology. In accomplishing that end, the SRD program has been very successful and we feel we can be justifiably proud of our achievements over the past 10 years.

Our own *Journal of Physical and Chemical Reference Data* is now in its seventh year of publication and has evolved into a major outlet for SRD compilations. The *Journal* currently has 1200 subscribers, including subscriptions in 44 foreign countries, and has sold over 19,000 individual off-prints of articles in the past six years.

It is interesting to note that the *Journal* has gained wide acceptance in libraries in the academic community. Fifty-four of the 55 leading physics departments in the U.S. currently subscribe to the *Journal* and at least one state university in each of the 50 states is now a subscriber. On the industrial side, nine out of the ten top corporations of the Fortune 500 list subscribe to the *Journal*. Eighteen of the 20 chemical companies whose sales exceeded

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COVER STORY

$1 billion in 1976 also subscribe. And I think most importantly, the librarians tell us that the *Journal of Physical and Chemical Reference Data* is one of the most frequently used journals on their shelves.

During the last 10 years a unique management style has evolved for the SRD programs. We have found that critical evaluations are most successfully carried out by experts who are able to keep up to date in their own specialty. We have therefore physically located our data projects in active research environments in a variety of different institutions. This allows us to take advantage of the available talent and also assures that the knowledge of the most advanced laboratory techniques can be factored into the evaluation process.

The core of the program is a set of 22 continuing data centers; 14 of them are located in the technical divisions of NBS, and eight are located at universities and other private institutions. Each has a well-defined technical scope, in an area where we can foresee a long-term demand for data.

We also have short-term projects that permit us to respond rapidly to newly emerging needs for data. Such projects have a more narrow scope than the continuing centers and often produce a single compilation or critical review on a one- or two-year time scale. Most of our contracts are small, ranging from $5000 to 100 000. In many cases, we obtain appreciable contributions-in-kind from the institution involved, which greatly increases the leverage of our directly appropriated funds.

In addition to continuing data centers, 31 short-term projects are underway. Together, these projects, which include work at 27 universities and private institutions, are referred to as the National Standard Reference Data System (NSRDS), and they are managed through the Office of Standard Reference Data at NBS. This office arranges for publication of all of the products of the NSRDS efforts.

One of the most difficult tasks that we at the National Bureau of Standards face in managing the National Standard Reference Data System is to assess needs for data compilations and to allocate resources to meet these needs. Clearly, the amount of data reported worldwide each year is many times larger than we can handle and we therefore must establish priorities.

Projects which address needs in important national programs are given highest priority. We also favor projects whose outputs will be useful to several different user groups. The availability of an appropriate theoretical framework upon which to base the work is another important factor. Of course, the willingness of other parties to help support the work, either by joint funding or assistance in kind, gives us a good indication of the urgency. In this context, we are currently collaborating on a number of projects with other federal agencies, professional societies, industrial trade associations, and a variety of international organizations. These organizations provided very significant financial support for our standard reference data efforts.

Using these general guidelines to set priorities, we have looked at the needs for new data activities in a wide range of the economy. We have identified five areas that we consider to be highest in priority:

Thermal data for the organic chemical and fossil fuel industries; physical reference data for medicine and biology; data on stability of alloys and ceramic materials; data on fracture properties of structural materials; and data for chemical modeling of water pollutants.

Let me give you some detail on the first two of these areas to convey the flavor of what might be possible. The organic chemicals and fossil fuel industries are among the most energy and materials intensive industries in the American economy. These industries include 40 percent of all chemical processing and the bulk of our gas and electric industries. They share common resources and common problems:

—Feedstock shortages;
—Rising energy costs;
—Increasingly stringent pollution restrictions.

A broad base of material properties is essential for these industries to respond effectively to these challenges. We believe that direct industry support can be obtained for a portion of this work; however, the diverse character of the users—large companies and small, suppliers and consumers, plant construction firms as well as production companies—makes it appropriate to build from a broad base of government funding.

The specific data needed here are thermochemical and thermophysical data on coal, coal liquids, celluloses, and a variety of fluids both pure and mixed. Much of the effort of the planned program will be spent developing procedures for predicting the properties of these substances over a wide range of temperature, pressure, and composition.

A project that we have currently underway on ethylene properties serves as an excellent mode for what we are planning in this broader program. Ethylene has a production worth $3 billion annually. It is the starting point for the production of plastics, synthetic fibers, antifreeze, solvents, and many other products. Yet the physical properties of this pure fluid were so poorly known when we began our study three years ago that the resulting uncertainties were unacceptable when ethylene was bought or sold.

To remedy these problems, the Standard Reference Data (SRD) study is assembling and evaluating

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Selected Questions and Answers

Dr. Johnson

Senator Stevenson

Subsequent to these hearings the Congress passed the Standard Reference Data Authorization Bill which was enacted into law on July 21, 1978. This Act (Public Law 95-322) established appropriations ceilings for the SRD Program for the next three years as follows: $3.575 million for FY 79, $4.375 million for FY 80, and $5.25 million for FY 81. In establishing these new ceilings, the Congress allowed additional funds to take care of the pay raise costs, and it recognized the need and added funds for modest growth in this important national program.

Senator Stevenson: Can you describe the Bureau's procedure for setting priorities for work to be done under the standard reference data system?

Dr. Johnson: We have our program divided roughly, sir, into four areas. Those areas deal with energy and the environment, with industrial process design, with materials utilization, and with physical sciences. We have program managers in each of these areas, and our program managers are in frequent contact with users of the data and with related trade organizations. Thus, they assess the needs directly from actual users of the data.

We also have the National Academy of Sciences-National Research Council Evaluation Panels, which Dr. William O. Baker* was representing for you here today [in earlier testimony]. The evaluation panels give us advice on priorities. In addition there is a special National Academy Panel on Data which broadly assesses the needs for data in the country. We take advice from all of these sources and then follow the priority setting procedures already outlined.

Senator Stevenson: What indicators do you use to determine how extensively the products in the standard reference data program are used and its value to the users?

Dr. Johnson: We get advice in that respect directly from users in the field through our program managers. They are in constant contact with professional societies, trade associations, and other federal agencies. We also get some information on the use of our products from the National Academy panels that we are involved with.

We have on occasion sent out questionnaires asking subscribers to our information how they use the information and how extensively it is used.

Senator Stevenson: You have cited ethylene as a case where the Bureau and industry have worked together. Is that a typical mode of operation between the Bureau and industry?

* Baker is chairman of the NBS Steering Committee for the National Academy of Sciences-National Research Council Evaluation Panels.

Dr. Johnson: Well, it certainly is in that area of our program and I hope it to be typical of the kind of mode of operation that we will have in all areas in the future. We have been attempting to develop this style in several new areas but it has been difficult. In areas where the industry is represented by many different firms it is difficult to get the firms together sufficiently to acquire the kind of resources necessary to engage in a joint project of this kind. As Dr. Ambler* indicated, in the case of ethylene there are seven different producers sharing the expenses with us.

Senator Stevenson: You said there are five areas of future expansion in the standard reference data program. What kind of impact do you expect this expansion to have on the budget in the future?

Dr. Johnson: We are currently reviewing program plans in certain of these areas, and we are at a less mature state with program plans in other areas; but we do hope that there's going to be an opportunity for expansion into these new activities.

The five areas that I listed for you were indicated in priority order. It is our intention to attempt to follow the priority order in the budget process.

[Senator Stevenson's questioning of Dr. Johnson concluded with several inquiries concerning the funding of the SRD program in Fiscal Year 1979. (Dr. Ambler had earlier apprised the Committee of the proposed levels of funding for the program: $3.152 million in FY 79, $3.75 million in FY 80, and $4.5 million in FY 81). The Senator was interested in knowing whether funding would track inflation and allow for real growth. Finally, he asked this:]

Senator Stevenson: Does it do the opposite? Is there a real decrease?

Dr. Johnson: If there is a pay raise in the fall, we estimate that that pay raise will cost us about $150 000. That, in effect, will be a decrease in the program if the FY 79 level is fixed at $3.152 million.

* Ernest Ambler, director of NBS

existing data and providing certain key measurements. A formula is being developed to generate a value for any desired thermodynamic property of ethylene at the temperature and pressure of interest. SRD will then package ethylene data from this generalized base in a variety of different ways to meet the specific needs of users. Clearly, a very broad range of producers as well as consumers of ethylene will benefit from these efforts. The total cost of the 5-year project will be $490 000, of which 52 percent will come from industrial sponsors, and 48 percent from NBS appropriated funds.

We can identify at least 16 other industrial fluids that demand the same kind of attention as ethylene. We believe that a critical SRD evaluation of these materials will have a significant impact on the affected industries.

In the second area, a serious need has been identified for reference data from the physical sciences for applications in medicine and biology. The whole range of techniques now used for therapy, diagnosis, and research in these areas requires quality data to determine proper application and to interpret results.

For example, the delivery of the proper radiation dose to a patient undergoing radiation therapy requires quantitative data on the absorption of the radiation in the various layers of tissue through which it must pass. This absorption is a physical process, and it can be calculated from the information on the interaction of the radiation with each type of tissue.

We believe that better data can be made available and that extrapolation techniques can be developed to extend the existing data into the appropriate ranges. A new SRD project in this area would have significant impact on the quality of health care. In each of the other three areas we are equally confident that the SRD efforts can have broad impact.

In summary, let me emphasize that the generation of Standard Reference Data involves a creative effort and adds value to the enormous U.S. investment in research and development. It pulls together the results from many diverse research activities, and it organizes these results into a more useful form. Once an SRD evaluation has been completed, the whole is definitely greater than the sum of its parts.

We are enthusiastic about continuing the Standard Reference Data Program and we are proud of its accomplishments. We urge you to continue to support these important activities. □

DATA PREDICTION

by Sherman Fivozinsky

Remember the TV commercial a few years ago with the big football player Alex Karras? After dealing a breathtaking blow to an opponent, Karras would turn to the camera and say, "My job is to plug holes."

One of our primary jobs in the NBS Standard Reference Data program is to plug holes, too, although of a very different kind. We deal with gaps in technical information, and unlike Alex Karras, we sometimes meet our challenge with an indirect assault.

Let me explain.

The objective of any data program is to make it as easy as possible for people to find the information they need—good information. Traditionally, this involves starting with laboratory results—data produced experimentally—and critically analyzing the information to determine its validity.

Sometimes, however, data can be *predicted* with a high degree of accuracy without going near a laboratory. This indirect technique, data prediction, is a natural extension of the evaluation process. It is based on a careful application of theoretical techniques, extrapolation procedures, and existing data. The approach is to combine the data and calculational procedures to produce a more comprehensive data set than the measured data alone would have allowed. The errors inherent in the experimental measurements and in the theory or extrapolation procedures are carefully analyzed in order that error limits can be placed on the predicted data.

An expansion of the Standard Reference Data Program in the area of prediction of data required for chemical processes design is planned. The effort will develop techniques to predict thermophysical and thermochemical properties of substances, including solids and fluid mixtures. These techniques will be evaluated and validated

Dr. Fivozinsky is assistant to the chief, Office of Standard Reference Data.

and applied to providing data for industrially important compounds, particularly alternative feedstocks.

A number of examples of such data prediction have already occurred in publications of the National Standard Reference Data System. One involves the prediction of transport properties (viscosity and thermal conductivity) of a number of important fluids. The transport properties were theoretically calculated based on known equilibrium thermodynamic properties, available transport property data, and intermolecular potentials for the substances in question. In the case of fluorine, which is a highly corrosive and difficult to handle substance, almost no experimental transport property data existed.[1] The prediction methods allowed determination of the transport properties of fluorine over a wide temperature range with error estimates between 5 and 20 percent. Figure 1, which shows the viscosity of saturated liquid fluorine, illustrates how data can be predicted reliably at temperatures far beyond the temperature range studied in the laboratory.

Another field where data prediction is already useful is in compilations of the energy levels and transition probabilities of atoms and atomic ions.[2] Atomic energy levels are derived from measured wavelengths of atomic spectral lines. However, very often too few lines have been observed to determine the higher energy levels, particularly the energy necessary to ionize the atom. Under these circumstances values for the ionization energy can be predicted by extrapolation along isoelectronic sequences, i.e. by intercomparison of different ions having the same number of electrons and thus similar atomic and spectral properties. (Figure 2 graphically displays such a sequence). The same type of extrapolation has been used to predict transition probabilities in highly ionized atoms which are very difficult to study in the laboratory. These techniques provide important data needed for development of magnetic fusion energy.

References

1. *The Viscosity and Thermal Conductivity of Gaseous and Liquid Fluorine* H. J. M. Hanley and R. Prydz, *J. Phys. Ref. Chem. Data*, 1,1101, (1972).
2. *Atomic Spectral Data, J. Phys. Chem. Ref. Data Reprint Package*, American Chemical Society, Washington, D. C. 20036.

Figure 1—*Viscosity for saturated liquid fluorine as a function of temperature.*

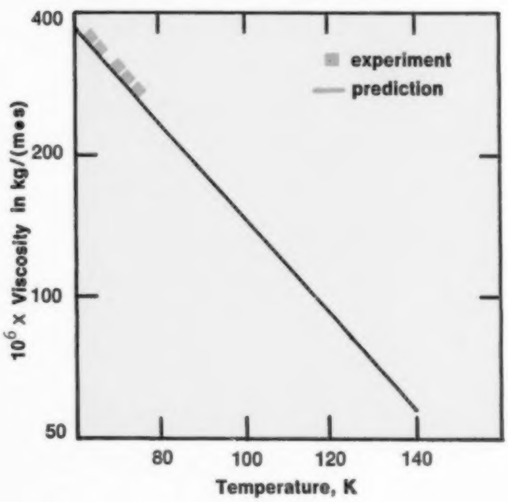
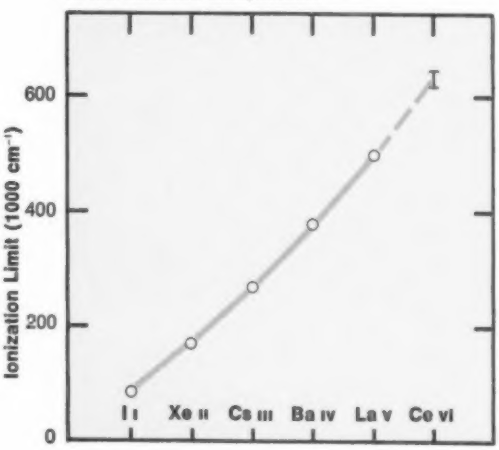


Figure 2—*Ionization limits in the I I isoelectronic sequence. The point for Ce VI is the result of the indicated extrapolation.*



ON LINE WITH INDUSTRY

THREE IR-100 AWARDS FOR NBS RESEARCHERS

by Michael Baum

Five researchers from the National Bureau of Standards received awards last month from *Industrial Research/Development* magazine for the invention of three new aids to precision measurement. The award-winning inventions—a positioning stage for microscopes, a control system for stepping motors, and a temperature reference cell—were judged to be three of the "100 most significant new technical products of the year," according to *Industrial Research/Development*.

The NBS "IR-100" winners: E. Clayton Teague and Fredric E. Scire of the NBS National Engineering Laboratory, who designed a specimen stage* for use in measuring very small dimensions with optical or electron microscopes; Dr. Howard P. Layer of the Bureau's National Measurement Laboratory, who invented a novel drive control system to increase the accuracy of the stepping motors commonly used in scientific equipment; and Drs. Billy W. Mangum and Donald D. Thornton, also of the National Measurement Laboratory, who developed an extremely precise temperature reference standard for use in hospitals and clinics.

Baum is a public information specialist in the NBS Public Information Division.

"Piezo-Flex" Stage

Teague and Scire's "Piezo-Flex" micropositioning stage was developed to meet a growing need for precise measurements made on a microscopic scale. Its first application was in the calibration of integrated circuit linewidths—measurements which must be made to an accuracy approaching the width of a few atoms and which are crucial to the proper design of microelectronic circuits.

Other people making measurements where the "Piezo-Flex" stage could be used include atmospheric and environmental researchers and biochemists, who measure the size of single microscopic particles or cells, and manufacturers in the synthetics industry, who make measurements on tiny man-made fibers.

Such measurements commonly are made by moving the specimen slowly past fine cross hairs or other reference marks in the field of the microscope. A number of mechanical stages have been devised to do this, but as the objects to be measured get smaller and smaller, the movement of the stage must become more and more smooth, mechanically stable, and isolated from outside vibration.

To meet these precise requirements, Teague and Scire designed a stage that combines stacks of piezoelectric transducers with a novel application of the principles of simple mechanics.

The transducers (which expand when an electric voltage is applied to them) provide the motion for the stage. They are fixed in a piece of solid metal which is honeycombed with a pattern of holes and slits that make it, in effect, a monolithic block of flexure pivots and levers that amplify the motion of the transducers.

Because the piezoelectric transducers can be activated by remote control, the stage can be completely isolated from vibration or other environmental disturbances, or designed for use in a special environment such as in high temperature or cyrogenic instruments. The stage can be made to move smoothly, as fast or as slowly as desired, through a range of 50 micrometers and positioned anywhere in the range to within 0.0001 micrometers.

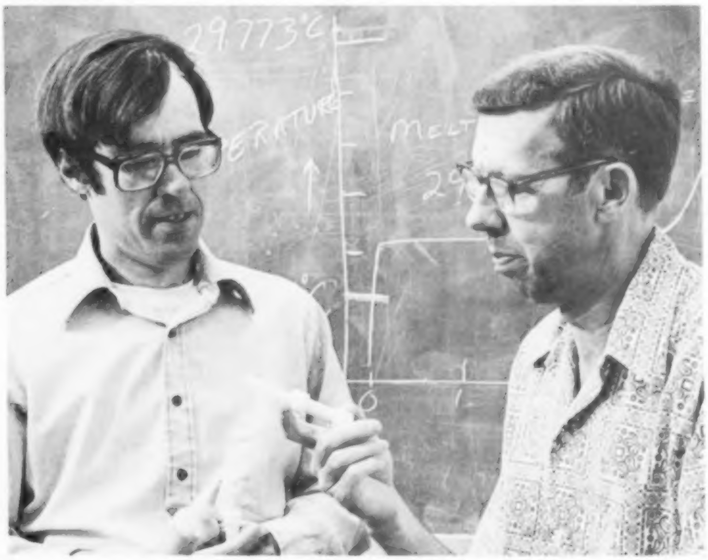
* The "Piezo-Flex" stage was discussed in the Staff Reports section of July 1977 DIMENSIONS; the temperature cell was reported in the November 1977 issue. This month's Staff Reports carries a paper by Layer on his stepping motor driver (see page 22).

Fredric E. Scire (left) and Clayton Teague consider a new configuration of the "Piezo-Flex" micropositioning stage.

Stepping Motor Driver

Improving the performance of sensitive instruments by reducing internal vibration was in part the motivation behind Layer's "mini stepping motor driver," the second NBS award winner.

Stepping motors—so called because the motor's shaft turns in a series of small increments instead of a continuous motion like most electric motors—are a favorite device of instrument makers who need to move things with slow or precisely con-



Left. Howard P. Layer makes an adjustment to one of his digital sine-cosine stepping motor drivers. *Below.* Donald D. Thornton and Billy W. Mangum inspect an assembled gallium temperature reference standard.

trolled motors. Strip chart recorders are a familiar application of stepping motors, but they are also used in a variety of applications from machine tool tables and manufacturing robots to spectrometers and tunable dye lasers.

In conventional systems, the stepping motor is powered by an electronic "driver" circuit that supplies electricity to the motor in a series of pulses, moving the motor forward or backward one step at a time. One consequence of this is that the motor's action is comparatively abrupt and jerky, and this motion causes unwanted vibrations in the system as a whole. In precision measurement machines, this vibration can be debilitating.

Another consequence is that the position of the motor's shaft cannot be adjusted any better than to within about half of the motor step size. (The most common stepping motor makes about 200 steps per revolution.) This also can be a problem when delicate measurements are made.

Layer's innovation was to change the nature of the control signals that drive the motor. Using microelectronics, Layer constructed a small computer that replaces the pulse signals with digitally generated sine and cosine waves.

The mini stepping motor driver breaks each step of the motor into 31 "substeps." This not only improves the precision with which the motor can be positioned by a factor of over 30, but also significantly reduces the inherent vibration in the motor, since the small substeps smooth the action of the motor.

Although the original system is designed for the common 4-phase stepping motor, according to Layer, the computer logic can be adapted to more exotic 3-, 5-, or 8-phase motors. The mini stepping motor drive is readily compatible with computer controlled instrumentation or feedback loop systems, says Layer.

Temperature Standard

Accurate temperature measurement is based on the use of a standard, recognized set of reference points determined by the physical properties of various materials. Mangum and Thornton's contribution was the development of a highly accurate reference point in a part of the temperature scale where convenient references did not exist and where hospitals and clinics regularly make delicate and temperature-sensitive measurements.

The cell itself—now manufactured by NBS as SRM (Standard Reference Material) 1968—consists of a sealed Teflon and nylon cylinder containing a sample of extremely pure gallium, a metal widely used by the semiconductor industry. The temperature reference is the melting point of gallium, slightly higher than 29.77 °C.

An important feature of the gallium reference point is its proximity to 30 °C, the standard temperature for enzyme reference tests used by hospitals and clinics. These valuable but very temperature-sensitive test procedures are used to detect evidence of such clinical conditions as cirrhosis, hypertension, and myocardial infarction.

Mangum and Thornton found that the melting point of their gallium samples could be reliably determined to within seven ten-thousandths of a degree using comparatively simple equipment and laboratory procedures, making it a very accurate and useful reference point. Prior to the development of the gallium reference, the closest temperature reference points to 30 °C were the ice and steam points of water (0 °C and 100 °C), both inconveniently far from the ideal temperature range, and the melting point of phenoxybenzene (26.87 °C), an organic compound difficult to obtain in sufficient parity and difficult to use in a general laboratory. In contrast, even technicians without specialized training working with simple equipment can obtain accurate results with the gallium reference.

SRM 1968 is currently being used by a number of clinical labs and instrument manufacturers.

DIGITAL SINE—COSINE MINI-STEPPING DRIVE

A digital driver for stepping motors has been developed at the National Bureau of Standards which provides smoother and more highly resolved incremental motion than conventional drives. Stepping motors are used in a wide variety of applications where slow or intermittent rotational motion is required. They are inherently computer compatible, but whether or not computer control is employed, the new driver can be used to advantage in such applications as measuring machines that require precise positional control, servo mechanisms of various sorts, milling-machine tables, lathes, and drafting machines.

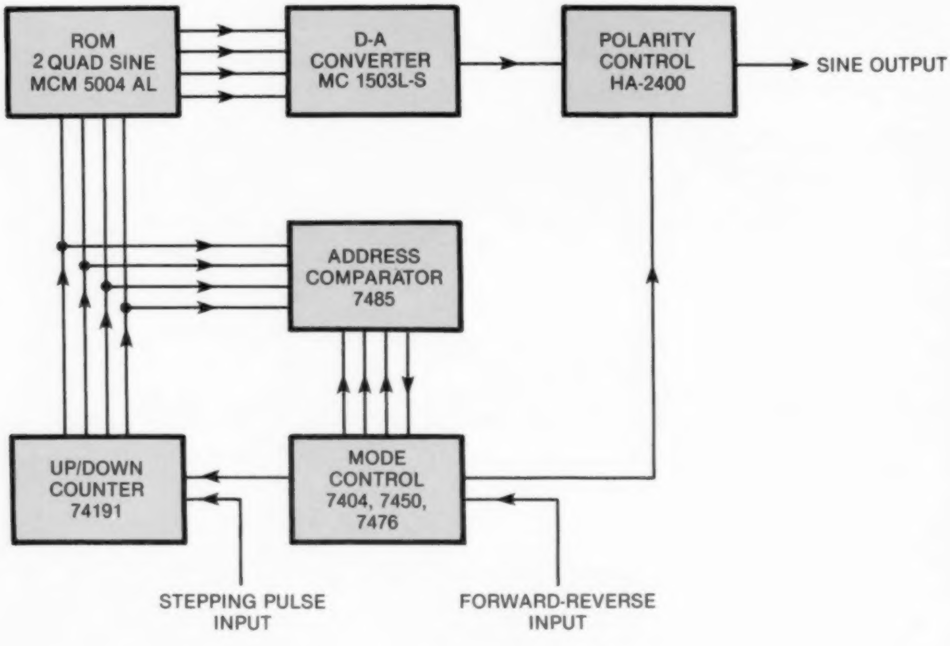
Howard P. Layer, Center for Absolute Physical Quantities, Room A319 Physics Building, 301/921-3360.

In conventional stepping motor systems, the speed and direction of rotation are determined by the phase and frequency of the power pulses that are applied to the stator windings; angular rotation is directly proportional to the number of switching pulses. Stepping motors are thus compatible with control systems that use standard integrated circuit logic augmented by power amplifiers. Some commercially available motors increment in steps of 0.72°, while motors having a 1.8° step angle are available in a wider range of sizes. This step size and the accompanying tendency to generate torsional vibrations in the driven elements during the step increment limit their utility in some cases. These limitations can often be mitigated by reduction gearing and viscous damping but at the expense of decreased slew rate and increased stepping response time. Alternatively, stepping motors can be driven smoothly, without steps, if the pulse drive is replaced by an electronic (analog) oscillator or a mechanical sine-cosine generator. Significant versatility, however, is lost: in the first instance, because of the finite minimum frequency of analog sinusoidal oscillators, and in the second, because exclusively electronic control is precluded.

Digital Sine-Cosine Driver

This paper describes an electronic system which overcomes the problems of large step size and torsional vibration generation although at a considerable increase in complexity relative to conventional driving circuitry. This system was designed for 4-phase stepping motors because they are commercially available in a wide range of performance characteristics and because of the simplicity of the sine-cosine symmetry. The principles outlined here, however, are applicable to stepping motors having other driving symmetries (e.g., 3-, 5-, or 8-phase) provided

Figure 1—*Block diagram of the digital function generator.*



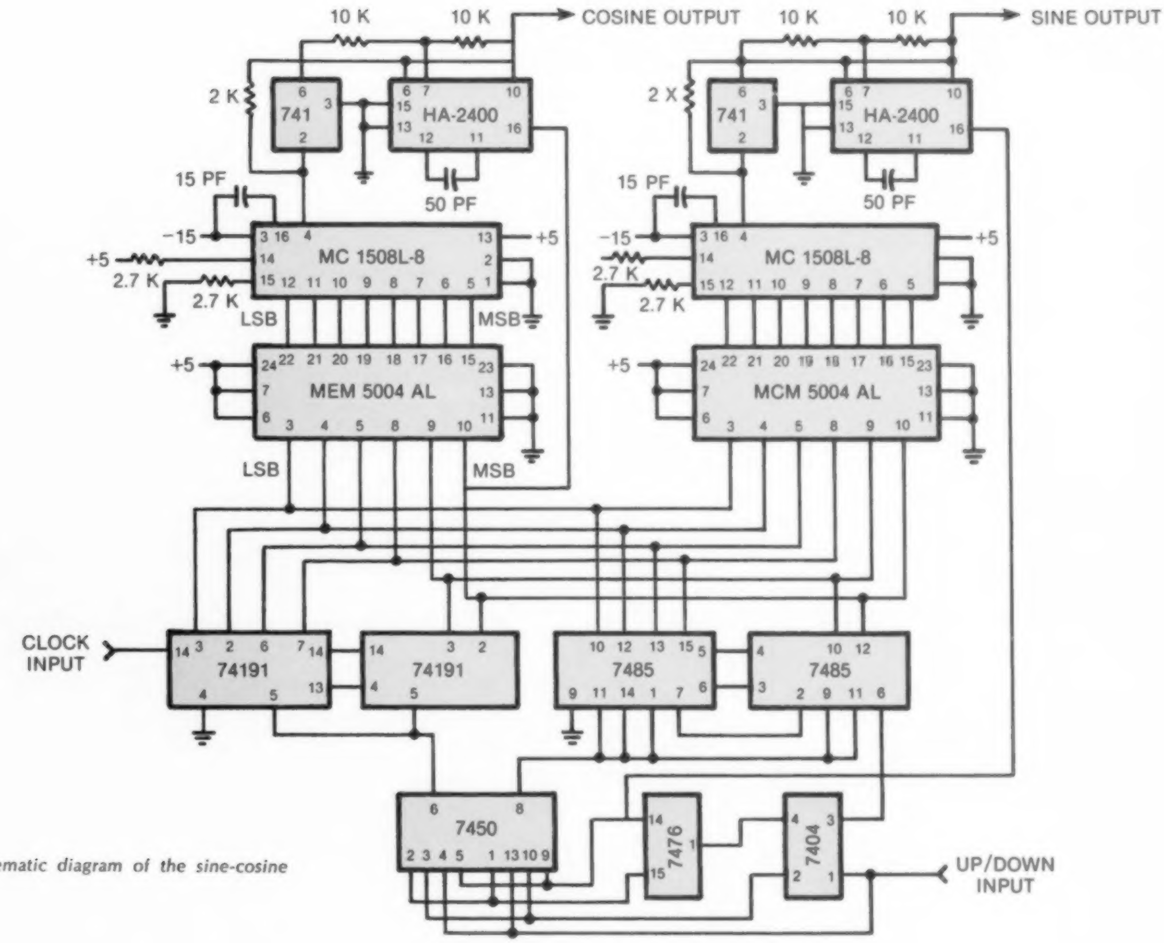


Figure 2—*Schematic diagram of the sine-cosine generator.*

the appropriate modifications are made in the logic design.

The principle of operation can be understood by referring to the block diagram in Figure 1. In unidirectional operation, the input stepping pulse increments the output of the up/down counter which addresses the read-only memory (ROM). Two quadrants of the sine function are stored in the ROM in 63 words of 8 bits each. The digital value of this function is converted into an analog voltage by the digital-to-analog (D-A) converter and the programmable polarity control, which is inverting or non-inverting as is appropriate to the quadrant being generated. The mode control provides a terminal reference address to the comparator which is 62 when the counter is counting up and 0 when it is counting down. When the counting address is equal to the reference address, a pulse from the comparator initiates three changes in the mode control: (1) the direction of counting is reversed, (2) the reference address is changed to its alternate value, and (3) the polarity control changes to its complementary inversion state. Thus, a bipolar continuous sine function is generated whose argument is specified in increments of 1/125 of a period and whose value is resolved to 1/255 of its amplitude. By altering the input pulse rate, the frequency of the output sine wave can be varied from 0 to over 10 kHz, the latter exceeding the slew rate input for high-resolution stepping motors. Bidirectional operation is obtained by providing external forward-reverse control to the up/down counter and additional control logic which provides a simultaneous change in the terminal reference address to the comparator. The complete diagram for the sine-cosine generator is shown in Figure 2. By storing the first and second quadrants of the sine and cosine functions, 255 sin (180/62)N and 255 cos (180/62)N, into the ROMs, a common up/down counter is used. Notice that the cosine inversion control is keyed to the most significant bit of the ROM address. This simplification is possible because the cosine changes sign between 30

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DIGITAL MOTOR CONTROLLER POWER DRIVER

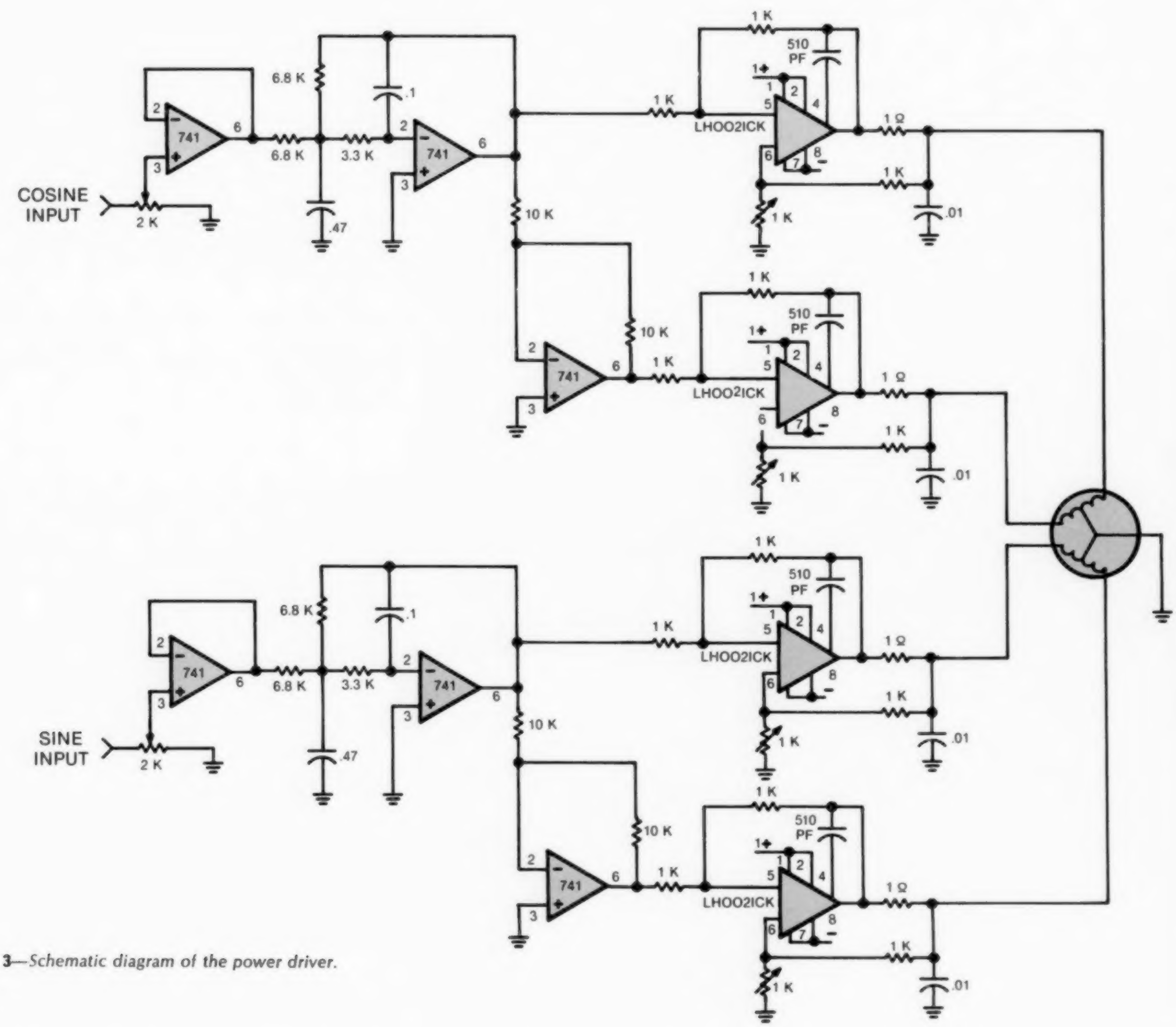

Figure 3—*Schematic diagram of the power driver.*

and 32 (11111 and 100000 in binary). Since one cycle of the sine-cosine generator increments the motor four conventional steps, the substep angle was 1/31 of the normal step.

Power Driver

The design of the power driver was determined by the requirements of the stepping motor and the characteristics of the power supplies to be used with it. For convenience, it was desirable to have an instrument that would operate from the NIM[1] system and use commercial integrated or hybrid circuit power amplifiers. The motor used in this study stepped in increments of 1.8° (5 percent accuracy); each winding was nominally rated at 0.88 A at 5.9 V. The single-step response time was 4×10^{-3} s and the slew rate was about 100 rpm.[2] The schematic of the power driver designed for this motor is shown in Figure 3. The input isolation stage is followed by a low-pass filter which protects the output amplifiers from fast rise-time signals from the D-A converter which would drive them into nonlinear operation. The design of the output amplifier feedback circuit is somewhat unconventional and requires explanation. By themselves, stepping motors have a complicated complex impedance; the addition of a reactive mechanical load to the motor further complicates their impedance. The difficulty involved in characterizing the electrical impedance by analytical methods necessary to design a feedback network indicated that an empirical determination of the parameters of the output

network would be more appropriate. It was observed that the smoothest rotational motion as well as the highest slew rate were obtained when a combination of positive and negative feedback was applied around the power amplifiers. The ratio of the positive to negative feedback is determined by the value of the resistance between pin 6 of the output amplifier and ground. When its value is 1000 ohms, the output stage acts as a high-impedance current source and conversely, when it is 0, the output stage acts as a low-impedance voltage source. The optimum value of this resistor was found quite readily once some experience with the system operation had been achieved. Subjective testing was appropriate in this exercise as the mechanical resonances that are excited by conventional driving circuitry are conspicuous because of their high amplitude and strong frequency dependence. With the load attached to the motor shaft, the vibrational characteristics of the system are observed by varying the rotational speed over its entire range. The value of the variable resistance which produces the smoothest motion is sharply defined if care is taken to accurately balance the maximum current in each of the four stator windings. When properly adjusted, the digital sine-cosine generator motor drive eliminates large-amplitude mechanical resonances and produces rotational motion which, over most of the operating range, is vibration free. Reducing the driving signal from its nominal rating of 5.9 to 2 V reduced the torque and maximum rotational rate but did not affect the rotational smoothness. The operating temperature of the motor is reduced significantly, however, and in this mode is preferred for low torque applications.

Performance

Discussion of the rotational accuracy achieved with the digital sine-cosine drive should be preceded by a clear understanding of the inherent limitations of stepping motors themselves. The stepping angle, and therefore the number of steps per revolution, is determined by the number of poles machined into the magnetic structure of the stator and the rotor. The rotational accuracy is determined by the precision with which the components were manufactured and aligned, by the uniformity of the magnetic fields generated by the current in the field coils, and by the excitation of torsional vibration modes in the driven elements. Since the number of steps per revolution is fixed, the intrinsic uncertainty in rotation of these motors is with respect to the stepping increment and is noncumulative. A nominal step accuracy of 5 percent represents an uncertainty of about 5.5′ in a 1.8° stepping motor. The performance of a motor driven by the digital sine/cosine generator is illustrated in Figure 4. Each 1.8° step is divided into 31 substeps of approximately 3.5′. The substep error is randomly distributed within a sinusoidal envelope having a width and an amplitude of about 0.5′ and a period equal to one conventional step. The large step error, which is the algebraic sum of the substep errors, is −1′ for the first step and −3′ for the second. While the total absolute uncertainty in the step angle remains the same, the reproducibility of the shaft position is improved significantly and never exceeded 0.5′ for any test angle. The sinusoidal variation of the step size could be removed by corrective programming of the ROM.

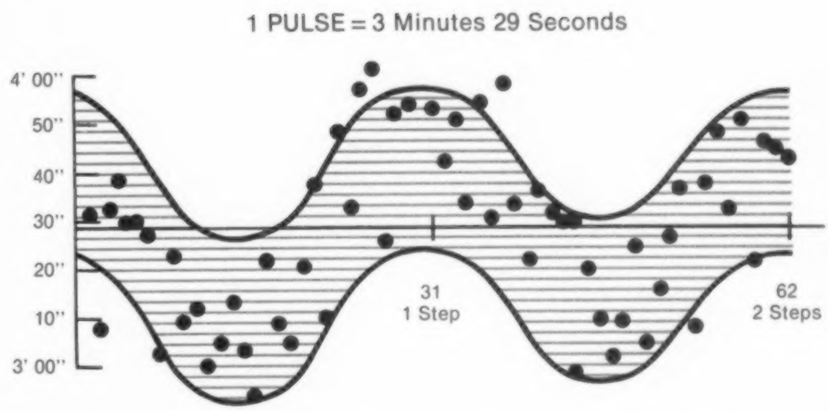

Figure 4—*Step angle as a function of the input pulses to the sine-cosine generator.*

The electronic stepping motor system described here increases the resolution of stepping motors by a factor of 31, does not diminish the slew rate, and has torsional vibration characteristics that are superior to conventionally driven motors. The positional accuracy of the stepping motor is preserved and reproducibility is significantly improved. Because of the inherent accuracy limitations of stepping motors, this drive will have greatest application in closed-loop systems or in applications where the driven element position is determined by an ancillary measurement.

REFERENCES

1. Standard Nuclear Instrument Modules, TID-20892 (Rev. 4), U.S. Atomic Energy Commission, Washington, D.C. (July 1974).
2. The motor whose performance is reported here is model MO61-FD302, manufactured by the Superior Electric Company, Bristol, CT. The use of this motor and other components in the electronic circuit does not constitute an endorsement by NBS nor does it imply that they are either the only or the best components available for this application.

turn page

IRON METAL STANDARD REFERENCE MATERIAL

The Office of Standard Reference Materials announces the availability of an SRM intended for clinical laboratory use in the calibration of instrumentation, the standardization of procedures, and the routine evaluation of daily working standards.

Standard Reference Material 937, Iron Metal (Clinical Standard), is produced in chip form for convenience in weighing. It was assayed at 99.90 $\pm$ 0.02 percent by chemical analysis. This assay value agrees, within the uncertainty limits, with the iron concentration obtained by subtracting from 100 percent the total concentration of the impurity elements determined.

The level of serum iron or iron binding capacity is altered in a number of conditions among which are hepatitis, obstructive jaundice, and various anemias. The reliability of these iron determinations is affected by the accuracy of the iron standard solution used in calibrating the instrumentation. This, in turn, is dependent upon a knowledge of the purity of the iron used to prepare the standard solution.

SRM 937, Iron Metal, may be ordered from the Office of Standard Reference Materials, Room B311, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234. The price is $43 for 50 grams.

MANAGING INFORMATION RESOURCES

Data is a very valuable resource. It is used to influence management decisions by providing decision-makers with timely and accurate information. Therefore, it is essential that data be easily accessible and properly and effectively managed. Database administration is an emerging discipline that is increasingly important to the successful management of an organization's information resources. It is comprised of a set of management procedures and technical functions that are aimed at controlling all the data, both automated and nonautomated. NBS researchers examine the concepts and functions of database administration, tools useful to the database administrator (DBA), and problems commonly encountered by the practicing DBA.

Belkis Leong-Hong and Beatrice Marron, Systems and Software Division, Room A367 Technology Building, 301/921-3491.

Database administration encompasses all the technical and management activities required for organizing, maintaining, and directing the database environment. This database environment consists of a database, a database administrator who manages the database environment, software tools that are used for administering and processing the data, and the users of the database.

The goals of database administration are: to optimize usage of the data in a shared database environment; to incorporate a systematic methodology for effective management and control of data resources; to improve reliability, security and integrity of the data; and to increase responsiveness to user needs.

DBA Study

Although there is agreement on the basic functions of database administration (shown in table 1), there is no standard set of duties and responsibilities for the DBA. This study was conducted to examine the concepts, functions, tools, and common problems of DBA's to help guide database technologists, managers, and new DBA's.

Database administrators in 12 Federal agencies were asked to identify the tasks they most often performed and those they judged most important. They were also asked what software tools were used and what problems they encountered. Finally, they were asked what advice they offered other DBA's. Interviews were informal but structured around a standard outline, the tasks listed in table 1, and a list of commonly used software tools.

The DBA's surveyed had either direct responsibility or a coordinating role in 75 percent of the activities listed in table 1. The most often performed tasks were database design, implementation, and maintenance/management, followed by database definition and performance monitoring/evaluation. The areas in which the DBA's said that they had little or no involvement were data collection and database documentation. The activities that the DBA's termed most important were database design, implementation, and definition. Although the DBA's judged their jobs as being more administrative than technical in nature, the tasks that they termed "most often performed" and "most important" show a definite technical orientation.

Use of Software Tools

Although there are many generalized software packages available for sale or lease, some DBA's reported that they chose to build their own software, either because they required special capabilities, because the commercial software was unavailable to them, or because they felt that they could build better or cheaper tools in-house.

Database Management Systems (DBMS) and data element dictionary/directory (DED/O) systems are among the most commonly used tools. Other tools reported as being used by all the DBA's surveyed include report generators and

information retrieval systems, on-line query systems, data/file maintenance systems, data editing and validation systems, and cross reference generators.

DBA Problems and Advice

In discussing the problems they encounter, DBA's cited non-technical problems related to lack of management commitment, jurisdictional questions, data ownership disputes, power struggles, poor communication, inadequate training, and high costs. Technical problems centered around both hardware and software limitations, lack of standards and documentation, and poor technical support.

Their advice is directed to other DBA's, but it could also be applied to the management of other technical activities within an organization. For example:

"Get complete management support, and get it early."

"Establish a strong organization, with good lines of communication."

"Be flexible, and adaptable to change."

"Involve the users in planning."

"Agree on standards first before designing a system."

"Don't try to do too much at once."

"Be patient. It may be a long time before you see results."

The results of the study and its implications for database administration within an organization are contained in NBS Spec. Pub. 500-28, *Database Administration: Concepts, Tools, Experiences, and Problems.* Two earlier NBS reports examine the technical features of both commercial and government-developed DED/D systems for controlling data resources: *Technical Profile of Seven Data Element Dictionary/Directory Systems* (NBS Spec. Pub. 500-3) by Belkis Leong-Hong and Beatrice Marron, and *A Survey of Eleven Government-Developed Data Element Dictionary/Directory Systems* (NBS Spec. Pub. 500-16).

Database Administration Functions

Database definition/redefinition: identification and definition of common data elements and their relationships to programs, files and systems; definition and review of data standards; restructuring of databases to meet changing user requirements.

Selection and procurement of hardware, software, and services related to database administration.

Database design/redesign to meet the needs of users; design of data structure, storage structure, mapping and search strategies, access methods, and supporting software.

Database creation: data collection, database loading and testing, implementation of data definitions, and supporting software.

Database security/integrity to guard against unauthorized access to the database and unauthorized alteration or destruction of the database, and to insure accuracy of data.

Database maintenance/management: maintenance and updating of database definitions, database documentation and supporting software; administration of management policies and formation of rules concerning use of databases.

Database performance monitoring and evaluation: review, testing, and evaluation of automated as well as procedural data activities; initiation of systems improvement; assessment of the impact of changes; and maintenance of state-of-the-art awareness.

Database enforcement: determination of compliance with established standard usages; development of database content, organization, and storage control procedures; access control and security.

Liaison with users, systems, and application analysts and with organizational management.

Training of users, staff, and management.

Table 1

CONFERENCES

For general information on NBS conferences, contact JoAnn Lorden, NBS Public Information Division, Washington, D.C. 20234, 301/921-2721.

REGULATORY ASPECTS OF BUILDING REHABILITATION

The progress and direction of efforts to develop building code provisions that address the growing trend toward rehabilitation of structures will be discussed October 30, 1978, at a conference to be held at the National Bureau of Standards in Gaithersburg, Md.

The conference will focus on a project being carried out with the State of Massachusetts by a number of organizations to develop interim provisions for alterations and additions to existing buildings which can be incorporated into the State building code. That project also aims to develop technical guides for regulatory management processes for existing buildings.

Participants with Massachusetts in this project and cosponsors of the October conference are NBS, the National Conference of States on Building Codes and Standards, Inc., the Association of Major City Building Officials, the National Academy of Code Administration, and the National Association of Housing and Redevelopment Officials. Three model building code organizations—the Building Officials and Code Administrators International, Inc., the International Conference of Building Officials, and the Southern Building Code Congress International, Inc.—are also working on the project and joining in sponsorship of the conference.

It is expected that interim building code provisions of the type being explored by these groups will establish a process which the design professional, building owner, and state and local enforcement official can use in evaluating proposed changes to existing buildings. The interim code provisions could later serve as a pattern for national application.

The conference will consist of several workshop sessions designed to encourage in-depth discussion by attendees and thereby gain input from the entire building community concerned with building rehabilitation. Among others, building designers, materials manufacturers, building designers, materials manufacturers, building regulators, and academic researchers are expected to attend. There will be a $10 registration fee.

For further information about the conference, contact James Pielert, B226 Building Research Building, 301/921-3447.

CERAMIC MACHINING SYMPOSIUM

A symposium called Ceramic Machining and Surface Finishing II will be held at the National Bureau of Standards November 13-15, 1978. The purpose is to assess and record recent progress in the developing science of ceramic machining and surface finishing and to provide the reference and stimulus for further progress in this technologically important field.

The scope of this symposium will be similar to that of the first symposium on this subject, which was held at NBS in 1970*. Accordingly, it will include papers on the following topics:

- Techniques and Mechanisms of Material Removal and Shaping
- Techniques and Mechanisms of Surface Finishing
- Surface and Subsurface Characterization/Evaluation
- Effect on Mechanical and Other Material Properties

The meeting will encompass both conventional and non-conventional techniques of ceramic machining, surface finishing and analyses. Studies concerned with materials of advanced technological importance, e.g., for use as turbine components, bearings, radomes, etc., will be emphasized.

The development of surface compressive layers (by ion-exchange or glazing) and the use of ceramics as machining tools will not be included since these are important, substantial topics in themselves and do not extensively overlap with the subject of this symposium. Work in related fields (sliding wear, indentation, particle impact and erosion) will be discussed in terms of machining and surface finishing.

Finally, while the symposium will focus on the scientific aspects of machining mechanisms and effects, papers representing comprehensive reviews or significant advances in ceramic machining technology will be presented.

A panel discussion is planned and floor discussion will be encouraged. The proceedings will be published in book form.

This Symposium will be held in conjunction with the fall meeting of the Basic Science Division of the American Ceramic Society. A registration fee will be charged.

For further information contact: Ronald B. Johnson, B348 Materials Building, 301/921-2835.

** Proceedings published as: "The Science of Ceramic Machining and Surface Finishing," NBS Special Publication 348. Edited by S. J. Schneider, Jr. and R. W. Rice, 1972. Order by SD Catalog No. C13.10:348, $5.25.*

CONFERENCE CALENDAR

October 30
THE REGULATORY ASPECTS OF BUILDING REHABILITATION, NBS, Gaithersburg, MD; sponsored by State of Mass., NSCBSC, AMCBO, three model building code organizations—BOCA, ICBO, SBCC; NACA, NAHRO, and NBS; contact: James Pilert, B226 Building Research Building, 301/921-3447.

October 30-November 1
SEMINAR ON HUMAN BEHAVIOR IN FIRES, NBS, Gaithersburg, MD; sponsored by NBS; contact: Bernard Levin, B142 Technology Building, 301/921-3845.

November 2-3
ELECTROMAGNETIC WORKSHOP, NBS, Gaithersburg, MD; sponsored by NBS; contact: Dee Belsher, NBS, Boulder, Colo., 303/499-1000, x3981.

November 13-15
CERAMIC MACHINING AND SURFACE FINISHING II, NBS, Gaithersburg, MD; sponsored by NBS, Office of Naval Research, Air Force Office of Scientific Research, and the American Ceramic Society; contact: Bernard Hockey, A345 Materials Building, 301/921-2901.

*November 28-29
CONFERENCE ON PRODUCT REMANUFACTURING, NBS, Gaithersburg, MD; sponsored by the Office of Technology Assessment and NBS; contact: Eric Vadelund, A355 Metrology Building, 301/921-3751.

November 28-30
MECHANICAL FAILURES PREVENTION GROUP, San Antonio, Texas; sponsored by NBS and MFPG; contact: Harry Burnett, B264 Materials Building, 301/921-2813.

December 4-6
WINTER SIMULATION CONFERENCE, Miami Beach, FL; sponsored by NBS; American Institute of Industrial Engineers; Systems, Man, and Cybernetics Society; Institute of Electrical and Electronics Engineers; Operations Research Society of America; College of Simulation and Gaming, The Institute for Management Sciences; and Society for Computer Simulation, The Deauville Hotel Miami Beach, FL; contact: Paul F. Roth, B250 Technology Building, 301/921-3545.

December 13
IEEE SYMPOSIUM ON COMPUTER NETWORKING, NBS, Gaithersburg, MD; cosponsored by NBS and the Institute of Electrical and Electronics Engineers' Computer Society Technical Committee on Computer Communication; contact: Rob Rosenthal, B212 Technology Building, 301/921-2601.

December 18-20
WORKSHOP ON SOFTWARE TESTING AND TEST DOCUMENTATION, Bahia Mar Hotel, Ft. Lauderdale, FL; sponsored by NBS and IEEE Computer Society; contact: Edward E. Miller, Software Research Associates, P.O. Box 2342, San Francisco, CA 94126, 415/921-1155 or 415/957-1441.

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*April 3-5
SYMPOSIUM ON BUILDING SECURITY, NBS, Gaithersburg, MD; sponsored by NBS and ASTM; contact: John Stroik, A355 Building Research Building, 301/921-2107.

April 19-20
5TH ROOFING TECHNOLOGY CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS and NRCA; contact: Robert G. Mathey, B348 Building Research Building, 301/921-3407.

May 17
TRENDS AND APPLICATIONS SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and IEEE; contact: Shirley Watkins, B212 Technology Building, 301/921-2601.

June 11-15
SYMPOSIUM ON ACCURACY IN POWDER DIFFRACTION, NBS, Gaithersburg, MD; sponsored by NBS, National Research Council of Canada, and the International Union of Crystallography; contact: Stanley Block, A219 Materials Building, 301/921-2837.

* New Listings

PUBLICATIONS

TEACHER AIDS

by Stan Lichtenstein

The following materials produced by agencies of the federal government are recommended by DIMENSIONS/NBS for their potential value to educators as supplements to the classroom or school library.

A Concern for Safety: The Engineer's Role in Highway Safety

Included in this 16-page leaflet by David M. Baldwin, a Federal Highway Administration executive, are sections concerning design effects on accidents, roadside obstacles, and geometric design features, with analysis, statistical charts and tables showing recent trends in terms of deaths, mileage, and travel volume. Free. Send requests to:

Office of Public Affairs
Federal Highway Administration
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

The A-B-C of Desalting

Salt-to-fresh-water conversion processes are simply explained in this 32-page booklet, illustrated by easy-to-follow scientific drawings in both color and black and white.

A background discussion analyzes the water problem in terms of current usage (360 billion gallons a day, almost three times the rate in the late forties), population growth, and anticipated new industrial and agricultural demands. The publication then describes membrane, distillation, crystallization, and chemical salt-water conversion processes and the plants in which they are carried out. A glossary is included. Single copies free to educators. Available from:

Technology Transfer
Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C. 20240

It's A Metric World: The Inevitable Metric Advance

Three illustrated articles in an 8-page reprint from *American Education* discuss "large metered steps" that will move us toward the promised land of metrics, and some do's and don'ts based on experiences in other countries. Order for 80 cents a copy from:

Public Documents Distribution Center
Department 13
Pueblo, Colorado 81009

Retention of Minority Students in Engineering

The "critical need" to lower the engineering school dropout rate for members of minority groups is the subject addressed by this 101-page paperback by the Retention Task Force, Committee on Minorities in Engineering, of the National Academy of Sciences' Assembly of Engineering.

Illustrated with tables and charts, the study analyzes data on some 40 percent of all minority engineering students—blacks, Mexican Americans, Puerto Ricans, and Native Americans (Indians). A summary and recommendations chapter discusses mathematics and physical science preparation, motivation, financial difficulties, absence of self-confidence, personal or family problems, and the role of minority engineering student organizations. Free. Available from:

Committee on Minorities in Engineering
National Research Council, Assembly of Engineering
2101 Constitution Avenue, NW
Washington, D.C. 20418

Solar Info Source

A telephone information service as well as distribution center for materials on solar energy and its applications is operated by the National Solar Heating and Cooling Information Center. Phone (toll-free) 800/523-2929 (in Pennsylvania, 800/462-4983) or write the Center at P. O. Box 1607, Rockville, MD 20850. Researchers will answer general questions, do literature searches, or serve as a reference point for other information sources.

Fourth Report to Congress on Resource Recovery and Waste Reduction

A basic document for possible use in classroom discussion of issues related to ecology, the environment, and the quality of life, this is the latest of the Environmental Protection Agency's reports. Topics include the economics of a nationwide beverage container law, energy and material recovery, the concept of a "solid waste product charge," and other aspects of waste and resource recovery. Free. Available from:

EPA Press Office
401 M St., S.W.—Room 329
Washington, D.C. 20460

Voyager: Mission to the Outer Planets

Twelve succinct but generously illustrated pages describe a mission with special appeal for students thirsty for more than "local" planetary exploration. Here is a venture directed to the solar system's dimly lit outer reaches where the majestic, "unimaginably large and far away" Jupiter and Saturn hold sway, with covetous experimenters' eyes cast upon "a possible flight to Uranus, which is 2.87 billion kilometers from the Sun—19 times the distance from the Sun to the Earth." Free to educators. Available from:

National Aeronautics and Space Administration
Educational Programs Division
Washington, D.C. 20546

Lichtenstein is a writer and public information specialist in the Public Information Division.

Building Technology

Andre, J. N., and Clifton, J. R., Corrosion of Metallic Pipes Transporting Potable Water—Laboratory Testing Methods, Nat. Bur. Stand. (U.S.), Tech. Note 974, 36 pages (June 1978) Stock No. 003-003-01945-3, $1.40.

Clifton, J. R., Brown, P. W., and Robbins, C. R., Methods for Characterizing Adobe Building Materials, Nat. Bur. Stand. (U.S.), Tech. Note 977, 59 pages (June 1978) Stock No. 003-003-01940-2, $2.30.

Wyly, R. S., Parker, W. J., Pierce, E. T., Rorrer, D. E., Shaver, J. R., Sherlin, G. C., and Tryon, M., Investigation of Standards, Performance Characteristics and Evaluation Criteria for Thermoplastic Piping in Residential Plumbing Systems, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 111, 152 pages (May 1978) Stock No. 003-003-01934-8, $3.25.

Computer Science and Technology

Orceyre, M. J., Courtney, R. H., Jr., and Bolotsky, G. R., Eds., Computer Science and Technology: Considerations in the Selection of Security Measures for Automatic Data Processing Systems, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-33, 33 pages (June 1978) Stock No. 003-003-01946-1, $1.40.

Rosenthal, R., and Lucas, B. D., Computer Science and Technology: The Design and Implementation of the National Bureau of Standards' Network Access Machine (NAM), Nat. Bur. Stand. (U.S.), Spec. Publ. 500-35, 50 pages (June 1978) Stock No. 003-003-01949-6, $2.20.

Health and Safety

Richmond, J. C., Transfer of Monochrome Video Information From Magnetic Tape to Motion Picture Film for Archival Storage, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-31, 14 pages (May 1978) Stock No. 003-003-01932-1, 90 cents.

Ruegg, R. T., The Police Patrol Car: Economic Efficiency in Acquisition, Operation, and Disposition, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-15, 135 pages (Apr. 1978) Stock No. 003-003-01837-6, $3.

Fire Research

Weber, S. G., Translation Ed., Building Research Translation: The Behavior of Concrete Structures in Fire—A Method for Prediction by Calculation, Nat. Bur. Stand. (U.S.), Tech. Note 710-10, 83 pages (Mar. 1978) Stock No. 003-003-01896-1, $2.40.

Lasers and Their Applications

Day, G. W., and Stubenrauch, C. F., Laser Far-Field Beam-Profile Measurements by the Focal Plane Technique, Nat. Bur. Stand. (U.S.), Tech. Note 1001, 52 pages (Mar. 1978) Stock No. 003-003-01902-0, $2.20.

Low Temperature Science and Engineering

Frizén, D. J., and Mendenhall, J. R., Publications and Services of the Cryogenics Division, National Bureau of Standards, 1953-1977, Nat. Bur. Stand. (U.S.), Tech. Note 1005, 112 pages (Apr. 1978) Stock No. 003-003-01920-8, $2.75.

Measurement Science and Technology Policy and State-of-the-art Surveys

Baum, M. A., and Washburn, S. A., Ed., Science on Its Way to Work, Nat. Bur. Stand. (U.S.), Spec. Publ. 498, 44 pages (Apr. 1978) Stock No. 003-003-01943-7, $1.60.

Metrology: Physical Measurements

Cateora, J. V., Hanson, D. W., and Davis, D. D., Automatic Path Delay Corrections to GOES Satellite Time Broadcasts, Nat. Bur. Stand. (U.S.), Tech. Note 1003, 52 pages (Feb. 1978) Stock No. 003-003-01899-6, $2.20.

Mountain, R. D., and Mulholland, G. W., Calibration of Time Response of Thermometers: Concepts and Model Calculations, Nat. Bur. Stand. (U.S.), Tech. Note 959, 34 pages (Jan. 1978) Stock No. 003-003-01878-3, $1.40.

Nicodemus, F. E., Ed., Self-Study Manual on Optical Radiation Measurements: Part I—Concepts, Chapters 4 and 5, Nat. Bur. Stand. (U.S.), Tech. Note 910-2, 118 pages (Feb. 1978) Stock No. 003-003-01880-5, $3.

Nuclear Physics and Radiation Technology

Gimm, H. A., and Hubbell, J. H., Total Photon Absorption Cross Section Measurements, Theoretical Analysis and Evaluations for Energies Above 10 MeV, Nat. Bur. Stand. (U.S.), Tech. Note 968, 77 pages (June 1978) Stock No. 003-003-01941-1, $2.40.

Standard Reference Data

Janz, G. J., Allen, C. B., Downey, J. R., Jr., and Tomkins, R. P. T., Physical Properties Data Compilations Relevant to Energy Storage I. Molten Salts: Eutectic Data, Nat. Bur. Stand. (U.S.), Nat. Stand. Ref. Data Ser., 61, Part 1, 244 pages (Mar. 1978) Stock No. 003-003-01825-2, $4.25.

Publications stated here may be purchased at the listed price from the U.S. Government Printing Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, VA 22161. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

NEWS BRIEFS

BUREAU'S BUDGET IN FY 79. NBS will have $86.544 million of Congressionally appropriated funds in FY 1979, an increase of about $11.6 million over FY 1978. President Carter signed the bill that included the Bureau's appropriations on October 10.

METRIC SUPPLIERS SOUGHT. As part of its own metric conversion program, NBS wants to find manufacturers or distributors with products in metric dimensions from domestic sources. Because of the broad range of activities pursued by the Bureau, virtually any construction and engineering items, all types of scientific measuring instruments, and all classes of consumable supplies are of interest. Contact Mr. G. A. Cauley, Room A715 Administration Building, NBS, Wash., D.C. 20234.

POSTDOC'S WANTED BY NRC. Applications are now being accepted for the National Research Council's Research Associateship Programs for 1979. NRC postdocs are placed in participating Federal laboratories, including NBS. The programs provide opportunities for postdoctoral research in the fields of atmospheric and earth sciences, chemistry, engineering environmental sciences, life sciences, mathematics, physics, and space sciences. They are open to recent Ph.D. recipients and, in many cases, to senior investigators also. Applications must be made to the NRC and must be postmarked by January 15, 1979. Write the Associateship Office, JH 608-D3, NRC, 2101 Constitution Ave. N.W., Wash., D.C. 20418. Phone 202/389-6554.

STANDARDS FOR ALL. This month Puerto Rico and the Virgin Islands received new sets of weights and measures standards from NBS, marking the completion of a 13-year cooperative Federal-State-local effort to assure measurement uniformity throughout the U.S. Uniformity and accuracy are necessary to ensure fairness to both buyer and seller in commercial transactions. All fifty States, two territories, and the District of Columbia now have modern standards and laboratories necessary for enforcement of State and local weights and measures regulations.

OVERCOMING CORROSION. Metallic corrosion costs the American economy $70 billion a year (DIMS, June 1978). NBS recently published a booklet, "Corrosion Facts for the Consumer," which explains how to prevent and how to remove it. Single copies cost 80 cents and are available from Consumer Information Center, Pueblo, Colo. 81009 and from Superintendent of Documents, U.S. Government Printing Office, Wash., D.C. 20402. Ask for Stock No. 003-003-01947-0.

NEXT MONTH IN

DIMENSIONS NBS

Like the human fingerprint, chemical compounds have unique patterns that can be used for identification. Read about an increasingly important method of chemical identification, x-ray powder diffraction, in the next issue of DIMENSIONS/NBS.

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Prepared by the Public Information Division
Washington, D.C. 20234

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Juli Chappell, Editor

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Justine A. Williams, Editorial Assistant

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PHOTO CREDITS

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Chuck Savadelis: Page 20.

The Commerce Department's National Bureau of Standards was established by Congress in 1901 to advance the Nation's science and technology and to promote their application for public benefit. NBS research projects and technical services are carried out by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology. Manufacturing, commerce, science, government, and education are principal beneficiaries of NBS work in the fields of scientific research, test method developments, and standards writing. DIMENSIONS/NBS describes the work of NBS and related issues and activities in areas of national concern such as energy conservation, fire safety, computer applications, materials utilization, and consumer product safety and performance. The views expressed by authors do not necessarily reflect policy of the National Bureau of Standards or the Department of Commerce

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription: Domestic, $11.00, foreign, $13.75. Single copy: Domestic, $1.10, foreign, $1.40. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1981.

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